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Specification

Guiding Elements for a Printing Unit

The invention relates to guide elements for a printing unit in accordance with the preamble of claims 1 or 2.

A printing unit with two web guide elements, which are arranged in an inlet and an outlet area of a printing unit in such a way that, with the printing location disengaged, a web can be conducted through the printing location without touching, is known from DE 93 11 113 U1. The web guide elements are embodied as rollers, which are rotatably seated in lateral walls.

A turning bar is disclosed in one exemplary embodiment in USP 3,744,693, wherein a tube wall element made of a porous material which is permeable to air forms a closed pressure chamber together with a base body. The porous segment constitutes a wall of the chamber and is embodied to be load-bearing over the width of the latter - without a load-bearing support -. In a second example a segment with through-bores is arranged instead of the porous segment.

USP 5,423,468 shows a guide element which has an inner body with bores and an outer body of a porous material which is permeable to air. The bores in the inner body are only provided in the expected area of loop.

The object of the invention is based on producing guide elements for a printing unit.

In accordance with the invention, this object is attained by means of the characteristics of claims 1 or 2.

The advantages to be gained by means of the invention consist in particular in that a dependably and accurately operating web guide element of a printing unit is created. By means of an air cushion created by micro-openings, a high degree of homogeneity is created over the length of the air cushion, simultaneously along with small losses. In contrast to rollers, no inertia must be overcome - in particular in the course of changing speeds -.

By means of air outlet openings with diameters in the millimeter range, forces can be applied point-by-point to the material (impulse of the jet), by means of which the latter can be kept away from the respective component, or can be placed against another component, while by means of the distribution of micro-openings with a high hole density a broad support and, as a matter of priority, the effect of a formed air cushion is applied. The cross section of bores used up to now lay for example in the range between 1 and 3 mm, while the cross section of the micro-openings is smaller by at least the power of ten. Substantially different effects arise from this. For example, the distance between the surface with the openings and the web can be reduced, and by means of this, flow losses which occur outside of the effective areas of the web can be clearly reduced.

In contrast to components with openings, or bores, with opening cross sections in the millimeter range and a hole distance of several millimeters, a greatly more homogeneous surface is created with the formation of micro-openings on the surface. Here, micro-openings are understood to be openings in the surface of the component which have a

diameter of smaller than or equal to 500 μm, advantageously smaller than or equal to 300 μm, in particular smaller than or equal to 150 μm. A "hole density" of the surface provided with micro-openings is at least one micro-opening per 5 mm^2 (= $0.20/mm^2$), advantageously at least one micro-opening per 3.6 mm^2 (= $0.28/mm^2$).

Because of the embodiment of the openings as micro-openings, the air cushion is made more uniform and the flow volume exiting per surface unit is reduced in such a way that a flow loss can be acceptably small also in the areas around which the web is not looped.

The micro-openings can be advantageously designed as open pores at the surface of a porous, in particular micro-porous, air-permeable material, or as openings of penetrating bores of small diameter, which extend through the wall of a supply chamber toward the exterior. In another embodiment the micro-bores are designed as openings of penetrating micro-bores.

In order to achieve a uniform distribution of air exiting from the surface in the case of employing micro-porous material, without requiring at the same time large layer thicknesses of the material with high flow resistance, it is useful for the guide element to have a rigid air-permeable support, to which the micro-porous material has been applied as a layer. Such a support can be charged with compressed air, which flows out of the support through the micro-porous layer and in this way forms an air cushion on the surface of the component.

On the other hand, the support can be porous and have a better air permeability than the micro-porous material, but

it can also be formed of a flat material or formed material, which encloses a hollow space and is provided with air outlet openings. Combinations of these alternatives can also be considered.

For achieving a uniform air distribution it is moreover desirable that the thickness of the layer corresponds to at least the distance between adjoining openings.

In case of using micro-bores an embodiment is advantageous, wherein the side of the guide element which faces the web and has the micro-openings is embodied as an insert or as several inserts in a support. In a further development, the insert can be releasably or, if desired, exchangeably connected with the support. In this way cleaning and/or an exchange of inserts with different micro-perforations for adaptation to different materials and web widths is possible.

Exemplary embodiments of the invention are represented in the drawings and will be described in greater detail in what follows.

Shown are in:

Fig. 1, a schematic representation of several printing groups through which a web travels,

Fig. 2, a sectional view of a first embodiment of a guide element,

Fig. 3, a sectional view of a second embodiment of a guide element,

Fig. 4, a sectional view of a third embodiment of a guide element,

Fig. 5, a sectional view of a fourth embodiment of a guide element,

Fig. 6, a sectional view of a fifth embodiment of a guide element,

Fig. 7, a sectional view of a sixth embodiment of a guide element,

Fig. 8, a sectional view of a seventh embodiment of a guide element,

Fig. 9, a sectional view of an eighth embodiment of a guide element.

A schematic sectional view through three printing units 05, for example printing groups 05 for sheet work, in particular offset printing groups for sheet work, through which a web 02, for example a web 02 of material 02, or web 02 of imprinted material, runs sequentially, is shown in Fig. 1. However, the printing groups 05 can also be designed in different ways, for example as three-cylinder offset printing groups 05, as a direct or flexographic printing group, as a printing group for letterpress or rotogravure printing, or different from each other. For example, at least one of the printing groups 05 designed for sheet work has a guide element 01, in particular a web guide element 01, at least in the outlet area (in Fig. 1 in the inlet and outlet area) of its printing gap 10, for changing the direction of the freshly imprinted, not yet dry web 02 at the outlet of the printing group 05, for example for conducting it to the printing gap 10 of the next following printing group 05 in the correct orientation.

A printing group 05 following the first printing group 05 has a web guide element 01 in both the inlet and the outlet area of the printing gap 10 in order to be able to conduct an already imprinted web 02 through the printing gap

10 in a contactless manner while the printing location is disengaged. This printing group 05 can be operated as an imprinting-type printing group 05 or as a printing group 05 for flying printing forme change, alternatingly with a second such printing group 05. In one operational situation the web 02 is imprinted by one of the printing groups 05 while passing without contact through the second of these printing groups 05. In another operational situation this is reversed. The two web guide elements 01 are spatially arranged, for example in such a way that the web 02 extends substantially perpendicularly in respect to a connecting plane of the two cylinders constituting the printing location. During imprinting operations, one of at least two printing units 05 is in contact with and imprints the web 02, while the other is disengaged and the web 02 runs through it without contact. The printing press preferably has five printing units 05, wherein in one mode of operation one of the five printing units is passed without contact, while the web 02 is imprinted by the remaining four printing units 05 in four colors (for example on both sides). In the other, second operational situation the printing unit 05, which previously had been passed without contact, is placed into operation in the printing process, while one of the four printing units 05 which had previously been printing is passed without contact. At least the two printing units 05, through which passage without contact is to occur, have guide elements 01, described below, in each of the inlet and outlet areas of the printing gap 10.

At least one of the two web guide elements 01 of the printing group 05 designed for alternating printing and/or at

least the web guide element 01 arranged in the outlet area of the printing gap 10 of at least one printing unit 05 are or is embodied as a contactless operating web guide element 01, in particular as a rod 01, around which air flows, in the manner described in what follows.

The surface of the guide element 01 has openings 03, for example micro-openings 03, through which a fluid, a gas or a mixture, in particular air, which is under higher pressure than the surroundings, flows from an inside located hollow space 04, for example a chamber 04, in particular a pressure chamber 04, during the operation. An appropriate feed line for compressed air into the hollow space 04 is not represented in the drawings.

The guide element 01 has the micro-openings 03 at least on the side of its surface cooperating with the web 02, or on the side facing the web 02. However, it can also have the openings on other sides, not facing the web 02, or it can be made completely of a material which has the micro-openings 03 at least on its longitudinal section which works together with the web 02.

This simplest embodiment without a preferred direction for the arrangement of the openings 03 becomes possible because of the design of the openings 03 as micro-openings 03, because by means of this a thinner, but more homogeneous air cushion is produced, at the same time a required, or resulting volume flow, and with that also a flow loss over the "open" side, is considerably reduced. In contrast to openings with a large cross section, the high resistance of the micro-openings 03 has the result that the "non-coverage" of an area of openings does not lead to a sort of short-

circuit flow. The partial resistance falling off via the openings 03 is given a greater weight in the total resistance.

In a first embodiment (Figs. 2 to 6), the micro-openings 03 are embodied as open pores on the surface of a porous, in particular micro-porous, air-permeable material 06, for example an open-pored sinter material 06, in particular a sinter metal. The pores of the air-permeable porous material 06 have a mean diameter (mean size) of less than 150 μm, for example 5 to 60 μm, in particular 10 to 30 μm. The material is designed with an irregular amorphous structure.

The selection of the material, dimensioning and charging with pressure have been made in such a way that 1 to 20 standard cubic meters per m^2, in particular 2 to 15 standard cubic meters per m^2, exit from the air outlet surface of the sinter material. An air escape of 3 to 7 standard cubic meters per m^2 is particularly advantageous.

In an advantageous manner, the sinter surface is charged with an excess pressure of at least 1 bar, in particular more than 4 bar, out of the hollow chamber 04. Charging the sinter surface with an excess pressure of 5 to 7 bar is particularly advantageous.

If the hollow space 04 of the guide element 01 is essentially only made of a body of porous material 06 enclosing the hollow space 04 (i.e. without any further load-bearing layers), at least at its longitudinal section acting together with the web 02, this body, for example embodied in the form of a tube, is substantially embodied to be self-supporting with a wall thickness of more than or equal to 2

mm, in particular more than or equal to 3 mm (Fig. 2). If necessary, a support can extend through the hollow space 04, on which the body can be supported at points, or in certain areas, but which is not in active contact with the body. Such a body of porous material 06 can also be embodied in the form of a half shell, as represented in Fig. 3.

For achieving a uniform distribution of the air exiting at the surface of the micro-porous material 06, without requiring at the same time large layer thicknesses of the material 06 with a correspondingly high flow resistance, it is useful in an advantageous embodiment that the guide elements 01 have a solid support 07, which is air-permeable at least in part and on which the micro-porous material 06 has been applied as a layer 06 (Figs. 4, 5 and 6). Such a support 07 can be charged with compressed air, which flows out of the support 07 through the micro-porous layer 06 and in this way forms an air cushion at the surface of the guide element 01. In a particularly advantageous embodiment the porous material 06 is therefore not embodied as a supporting solid body (with or without a frame structure), but as a layer 06 on a support material, which has passages 08 or through-openings 08 and is in particular made of metal. A structure is understood to be the "non-supporting" layer 06 together with the support 07 - in contrast to, for example, the above mentioned "self-supporting" layers - wherein the layer 06 is supported over its entire layer length and entire layer width on a multitude of support points of the support 07. For example, the support 07 has over its width and length which is active together with the layer 06 a plurality of non-connected passages 08. This embodiment is clearly

different from the embodiment in which a porous material 06 extending over the entire width which is active together with the web 02 is designed to be self-supporting over this distance, and is only supported in the end area on a frame or support, and therefore must have an appropriate thickness.

In the exemplary embodiment represented in Figs. 4, 5 and 6, the support material substantially absorbs the weight, shearing, torsion, bending and/or shearing forces of the component, for which reason an appropriate wall thickness (for example greater than 3 mm, in particular greater than 5 mm) of the support 07 and/or an appropriately reinforced construction has been selected. The support 07 which, for example, delimits the hollow space 04 toward the layer 06, or which constitutes the hollow space 04 by means of an appropriate shaping (for example tube-shaped in Fig. 4) has, on the side coated with the porous material, a plurality of openings 09 for the supply of compressed air to the porous material 06. Porous material can also be partially located in the openings 09 of the support 07 in the area of the walls.

As represented in Figs. 4, 5 and 6, the guide element has the support 07, also called the base body 07, with the hollow or inner space 04, for example a tube-shaped support 07 (Fig. 4), which has a plurality of the penetrating openings 09 in its wall radially as far as the surface. In principle, the support 07 can be designed with any arbitrary hollow profile, but advantageously with a ring-shaped profile. During the operation, a fluid, for example gas, which is at a pressure P greater than the ambient pressure, is blown through the hollow space 04 and the opening 09, for

example by means of a compressor, not represented. At least in the section provided with the openings 09, the surface of the support 07 has the layer 06 of a porous material, which also covers the openings 09 and extends continuously over the area working together with the web 02, i.e. a continuous surface at least in the area provided for looping the web 02.

In another embodiment (Figs. 5 and 6), the hollow space 04 is not constituted by a tube with a support 07 designed in a ring shape, but with a different geometry. Advantageously the support 07 has a wall 15 in the shape of a segment of a circle, or a wall 15 (in particular with a fixed radius, or radius of curvature R07 or R15 in relation to a fixed center M07), which is closed on its open side, for example by a cover 20. This wall 15 in the shape of a segment of a circle with the cover 20 can be embodied as one piece or as several pieces, which are however connected with each other. In Fig. 5 the angle gamma of the partial circle of the wall 15 having the openings 09 has been selected to be approximately 180°. With a defined width b01 of the guide element 01 - for example because of a maximum width predetermined for reasons of structural space - the largest possible area can be achieved with this step. With a desired or predetermined width b01, the radius R15 of the partial circle (or the tube as the raw material) is selected on the basis of the desired deflection (deflection angle alpha of the change of direction of the web 02), and an appropriate partial circle is used. In this way a change of direction takes place as "softly" as possible and is supported by the air cushion over the largest possible area in the available structural space.

In the representation of Fig. 6, the angle gamma of the partial circle is less than 180°, for example between 10° and 150°, in particular approximately 90° here. In a preferred embodiment for use in the area of the printing gap upstream and/or downstream of the printing unit 05, the angle gamma of the partial circle has been selected to be 10° to 45°, in particular between 15° and 35°. The width b01 has been selected, for example, between 30 to 150 mm, in particular 50 to 110 mm. The radius of curvature R15 of the wall 15 is for example between 120 and 150 mm, in particular between 140 and 200 mm. As in Fig. 5, the layer can be extended as far as the front cover 20, or it can only cover the curved wall 15 containing the openings 09. In its end areas the layer 06 can also be flattened to form a soft transition.

By means of the mentioned steps, a surface of the air cushion which is as large as possible and acts as a support can be achieved at a width b01 of the guide element 01 or a width b07 of the support 07 - for example a maximum width preset for reasons of structural spacing -. At a desired or predetermined width b01, the radius R07 of the partial circle (or the tube as the raw material) is selected on the basis of the required directional change (represented by way of example as the deflection alpha of the change of direction of the web 02 in Fig. 1 in the first printing unit 05), and an appropriate partial circle is used. By means of this a change of direction takes place as "softly" as possible and is aided by the air cushion over the largest possible area in the structural space available.

In an advantageous embodiment the design of the guide element 01 is such that the partial circle angle gamma of the wall 15 is formed from the deflection angle alpha desired for the course of the web, wherein gamma = alpha + delta, and delta is an addition for an assured run-up and run-off of the web 02 and is selected to lie between 0° and 50°, in particular between 10° and 30°. The radius of curvature R07 is then selected to be such that, taking the addition delta into consideration, the desired width b01 or b07 is maintained. The radius of curvature R15 (or R07) is then selected to be R15 (R07) = b01/(a * sin(y/2)). An excess projection possibly created by the layer thickness is negligible because of the slight thickness. Thus, while taking dependability into consideration, a large active surface is created along with an optimal use of the space.

With needed deflection angles alpha starting at, for example, 120°, a semi-circular profile or even a full circle can be of advantage for reasons of simplification. In this case the opening 09 and/or the layer 06 can include the full 360° angle, or only a partial circle.

Basically, other profiles differing from partial circles are conceivable for the area of the guide element 01 (or its curved wall 15) interacting with the web 02, for example as a section of an ellipse, parabola or hyperbola. In this connection the curved shape of the directional change can be optimized in view of a "soft" directional change. However, the partial circle shape has advantages in respect to standardization, material use and simplified manufacture.

In contrast to the embodiment of a guide element 01 wherein the porous material is not underlaid to a great extent by a support 07 or base body 07 having openings 09, but instead is only supported, for example in a bridge-like manner, on a frame-like support in edge areas, the embodiment in the shape of a base body 07 in the shape of a partial circle, ellipse, parabola or hyperbola directly underneath the layer has great advantages in respect to manufacture, dimensional stability, costs and handling. For example, with this embodiment at least half of the surface of the layer 06 working together with the web 02 is underlaid by the support 07, or its curved wall 15, and/or openings 09 or free cross sections have a diameter or a maximum inside width of 10 mm, in particular less than or equal to 5 mm.

In connection with the examples embodied with the support 07, the porous material outside of the passage 08 has a layer thickness which is less than 1 mm. A layer thickness between 0.05 mm and 0.3 mm is particularly advantageous. A proportion of the open face in the area of the effective surface of the porous material, here called degree of opening, lies between 3% and 30%, preferably between 10% and 25%. For achieving an even distribution of air it is furthermore desirable for the thickness of the layer to correspond at least to the distance between adjoining openings 09 in the support 07.

The wall thickness of the support 07 is - at least in the area with the layer - greater than 3 mm, in particular greater than 5 mm.

The support 07, provided with a hollow profile, if desired, can itself also be made of a porous material, but with a better air permeability - for example a greater pore size - than that of the micro-porous material of the layer 06. In this case the openings 09 of the support 07 are constituted by open pores in the area of the surface, and the passages 08 by channels which are incidentally formed in the interior because of the pores. However, the support 07 can also be constituted by any arbitrary flat material enclosing the hollow space 04 and provided with passages 08, or by formed material. Combinations of this alternative can also be considered.

In a second embodiment (Figs. 7 to 9), the micro-openings 03 are designed as openings of penetrating bores 11, in particular micro-bores 11, which extend outward through a wall 12, for example chamber wall 12, bordering a hollow chamber 04, for example designed as a pressure chamber 04. For example, the bores 11 have a diameter (at least in the area of the openings 03) of less than or equal to 500 μm, advantageously less than or equal to 300 μm, in particular between 60 and 150 μm. The degree of opening lies between 3% to 25%, in particular 5% to 15%, for example. The hole density is at least $1/(5\ mm^2)$, in particular at least $1/mm^2$ up to $4/mm^2$. Therefore the wall 12 has a micro-perforation, at least in an area located opposite the web 02. The micro-perforation advantageously extends over the area which works together with the web 02; however, it can extend - as the passages 08 and the layer 06 in the first exemplary

embodiment - over the full circumference of 360° since, as mentioned, the losses are kept within limits.

In a second example of the embodiment of the guide element 01 with micro-bores 11 (Fig. 8), the chamber wall 12 has, on the side facing the web 02, a curved wall 14 or a curved wall section 14 - comparable with the wall 15 described in connection with Figs. 5 and 6 -, which has the micro-bores 11. What has been said in connection with the angles alpha, gamma, delta and the width b01 or b07 (here b01 or b12) and the radius R15 (here R14) in connection with Figs. 5 and 6, as well as with the way of proceeding and the selection of the radii of curvature, should be applied in the same way to the instant example.

In an exemplary embodiment in accordance with Fig. 9, the wall 14 with the micro-bores 11 is embodied as an insert 14 or several inserts 14 arranged side by side in a support 16. The insert can be connected fixedly or releasably, or exchangeably with the support 16. The latter is advantageous in view of cleaning or an exchange of inserts 14 with different micro-perforations for adaptation to different materials (mass and/or surface structure) and web widths. In the variation of this embodiment with inserts 14 and/or micro-openings substantially arranged over the full circumference, such inserts 14 can for example be arranged on a support 16 extending in the hollow space 04. However, an embodiment is also advantageous wherein, as represented, the insert 14 with the openings 09 is only embodied over an angle segment with a curvature - in particular one matched to the path of the web -.

Again, what was said in connection with the angles alpha, gamma, delta and the width b01 or b07 (here b01 or b12) and the radius R15 (here R14) in connection with Figs. 5 and 6, as well as with the way of proceeding and the selection of the radii of curvature, should be applied in the same way to the instant example for embodying the curved surface of the insert 14, or inserts 14. However, here a projection between insert width and support width must possibly be taken into consideration. The curvature can be forced, for example, by an intentional excess width of the insert 14 in respect to the support 16 (or the fastening arrangement of the latter) in the form of a resultant bending.

As represented, the releasable connection can be realized, for example, by grooves 17 in the support 16, which receive the ends of the insert. In addition, or instead, a connection can also be made by means of screwing or clamping.

A wall thickness of the chamber wall 12 (or wall 14 or insert 14) containing the bores 11 which, inter alia, affects the flow resistance, can be at 0.2 to 0.3 mm, advantageously at 0.2 to 1.5 mm, in particular at 0.3 to 0.8 mm, for all examples concerned. With the smaller ones of the wall thicknesses mentioned in particular, a reinforcing structure, for example a support extending in the longitudinal direction of the guide element 01, in particular a metal support, can be arranged in the interior of the guide element 01, in particular in the hollow space 04, on which the chamber wall 12. the wall 14, or the insert 14 are supported at least in part or at points. This can for example be provided by ribs

which are spaced apart from each other in the axial direction.

In connection with the embodiment of the micro-openings 03 in the form of bores 11, an excess pressure in the chamber 04 of, for example, 0.5 to 2 bar, in particular 0.5 to 1.0 bar, is advantageous.

The bores 11 can be designed cylindrical, funnel-shaped or in another special shape (for example in the form of a Laval nozzle).

The micro-perforation, i.e. the making of the bores 11, preferably takes place by drilling by means of accelerated particles (for example a liquid, such as a water jet, ions or elementary particles), or by means of electromagnetic radiation of high energy density (for example light in the form of a laser beam). The making by means of an electron beam is particularly advantageous.

The side of the wall 12 (14) having the bores 11 and facing the web 02, for example a wall 12 (14) made of special steel, in a preferred embodiment has a dirt- and/or ink-repelling finish. It has a non-represented coating - for example of nickel or advantageously chromium - which does not cover the openings 03 or bores 11, which for example has been additionally treated - for example with micro-ribs or structured in a lotus flower-effect, or preferably polished to a high gloss).

List of Reference Symbols

01	Guide element, web guide element, rod
02	Web, web of material, web of imprint material, paper web
03	Opening, micro-opening
04	Hollow chamber, inner chamber, chamber, pressure chamber
05	Printing unit, printing group, offset printing group
06	Micro-porous material, sinter material, layer, micro-porous
07	Support, inner body, base body
08	Passage, through-opening
09	Opening
10	Printing gap
11	Bore, micro-bore
12	Wall, chamber wall
13	Feed line
14	Wall, curved, wall section, insert
15	Wall, wall, curved
16	Support
17	Groove
18	-
19	-
20	Cover
b01	Width
b07	Width

M07	Center
R07	Radius
R14	Radius
R15	Radius, radius of curvature
alpha	Deflection angle
gamma	Angle of partial circle